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AUTHOR Fetler, Mark
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ABSTRACT

An assessment was conducted in 1983 of the skills, knowledge, attitudes, and experiences of California sixth and twelfth grade students in the area of computer technology. Cognitive test questions were written to conform to a set of objectives used in the Department of Defense Dependents Schools (DoDDS) curriculum; attitude questions were obtained from the National Assessment of Educational Progress; and background questions were designed to assess relevant prior knowledge of and experience with computers. The questionnaire was administered to approximately 23,400 twelfth grade and 293,700 sixth grade students. Boys reported having more experience with computers than girls did, and this experience was associated with higher test scores. Nearly all groups studied showed a low level of understanding of the basic concepts of computer technology. A majority of students did exhibit awareness of certain basic concepts and hold positive attitudes towards computers. Even so, substantial percentages of students subscribed to various common misconceptions about computers. Students with parents having more education, or who worked professionally, had higher test scores than students with parents who had less education or who did unskilled work. A 10-item bibliography and a list of DoDDS student objectives related to computer literacy are provided. Supporting tables and graphs are appended. (Author/ESR)

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Computer Literacy in California Schools

by

Mark Fetler
California Department of Education
February, 1984

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Abstract

Findings from an assessment of the skills, knowledge, attitudes and experiences of California sixth and twelfth grade students in the area of computer technology are reported. Boys reported having more experience with computers, and this experience was associated with higher test scores, than girls. Nearly all groups studied showed a low level of understanding of the basic concepts of computer technology. A majority of students did exhibit awareness of certain basic concepts of computer technology, and did hold positive attitudes towards computers. Even so, substantial percentages of students subscribed to various common misconceptions about computers. Students with parents having more education, or who worked professionally, had higher test scores than students with parents who had less education or who did unskilled work.

Computer Literacy in California Schools

The computer can be a means of educating students and an object of study in itself.[1] Historically, in the public schools, there has been more interest in the former application than in the latter. These two applications are not mutually exclusive. Using the computer as an instructional tool invariably requires learning something about the machine and how to operate it. It is also true that the study of computers and programming can be a natural and stimulating way to learn problem solving skills and various mathematical and scientific concepts.

There is strong evidence for the growth of a serious interest in computer studies in California and nationwide. The California State Board of Education in 1983 made computer studies a part of its model graduation requirements, a measure which is being considered and duplicated in other states. The College Board in 1982 inaugurated an Advanced Placement test for high school students in the area of computer science. The National Center for Educational Statistics in 1983 initiated a nationwide study of computer literacy.

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[1] This study was carried out under the auspices of the California Assessment Program, which is mandated to assess annually the level of achievement in California public schools and to investigate factors related to changes in that achievement. The obtained information is reported to the California Legislature, and to all tested schools and districts. The opinions expressed here are not necessarily those of the California Department of Education.

The growing popularity of the computer in school curricula and the growing role of computers in the workplace, raise the concern that all students have the opportunity to benefit from instruction in computer technology. To the extent that enrollment trends in the area of computer studies follow those traditionally found in science and mathematics, girls are not benefiting from such instruction as much as boys. The primary goal of this study was to examine the knowledge, attitudes and experiences of California sixth and twelfth grade boys and girls in the area of computer technology. The study was designed to encompass the diverse educational objectives of many different district and school programs. The result was a baseline measurement. It should not be interpreted as an evaluation of a particular curriculum or educational policy.

Educators have witnessed in recent years a lively debate about what students should learn about computers. Statements of educational objectives have been published by the Committee on Computer Education (1972), the National Council of Supervisors of Mathematics (1978), Johnson, Anderson, Hanson, and Klassen (1980), Rogers (1982), and the Department of Defense Dependents Schools (1982), among others. Discussion of various key issues can be found in Seidel, Anderson and Hunter (1982).

The National Assessment of Educational Progress included several questions on computers in its 1978 mathematics assessment, which have been reported by Carpenter, Corbitt, Kepner Lindquist and Reys (1980). They concluded that a large majority of the 13 and seventeen year old students tested had little or no experience in actual applications of

computers. For example, only 8 percent of 13 year olds and 13 percent of seventeen year olds said they knew how to program a computer. By contrast, there was a somewhat higher level of awareness of the routine uses of computers. Understanding of more sophisticated uses of computers in complex decision making and mathematical modeling of problems was more limited.

The 1982 National Assessment of Educational Progress mathematics assessment repeated some of the computer questions asked in 1978. Between 1978 and 1982 the number of students with access to computers for learning mathematics almost doubled. Nearly one-fourth of 13 year olds and one-half of seventeen year olds had access to a computer in school in 1982. Students at both ages were more positive about computers in 1982 than in 1978. Even so, a substantial number of students continued to hold a variety of misconceptions about computers.

The California Department of Education in 1981 surveyed sixth grade school officials and students on computer use. Twenty-nine percent of the elementary schools surveyed possessed a microcomputer or computer terminal. Of the schools with equipment roughly one-half used the equipment for computer literacy instruction. Schools that reported using computers for student programming or creative applications tended to have higher socioeconomic status than schools reporting drill and practice applications. Boys were more likely to report use of a computer in school or at home than girls.

Method

Instrumentation

Twelfth grade survey. A committee of specialists in computer technology was assembled from the public school system, universities and industry. This committee designed a survey to assess a wide variety of instructional objectives in the area of computer studies, as well as attitudes towards computer technology, and relevant experiences with computers. Cognitive test questions were written to conform to a set of objectives that had been developed and used with the Department of Defense Dependents Schools (DoDDS) curriculum. These objectives are shown in Appendix A.[2] Test questions were reviewed for relevance and accuracy of content, sex and ethnic bias. All cognitive test questions were multiple choice with four options.

Attitude questions were obtained from a set that had been administered by the National Assessment of Educational Progress in its 1978 mathematics assessment. Each of the attitude questions requested the student to indicate agreement (Strongly disagree, Disagree, Undecided, Agree, Strongly Agree) with a particular statement. Statements included here were:

- Computers dehumanize society by treating everyone as a number.
- The more computers are used, the less privacy a person will have.

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[2] The terms, "computer literacy" and "computer science," as used in this study, should be understood in light of the described objectives. The number of questions relevant to each objective is written in parentheses after each statement. There were, in all, 430 questions, including 239 for the area of computer literacy and 191 for computer science. The Northwest Regional Educational Laboratory in Portland, Oregon, shared questions that had been written for a DoDDS evaulation and assisted in the question writing process.

- Computers will probably create as many jobs as they eliminate.
- Computers slow down and complicate simple business operations.
- Someday most things will be run by computers.
- A knowledge of computers will help a person get a better job.
- Computers can help make mathematics more interesting.

The committee designed the background questions to assess relevant prior knowledge of computers and experiences with them. These questions were:

- Indicate which of the following languages you have actually used to write and run computer programs. (BASIC, PASCAL, LOGO, PILOT, FORTRAN, COBOL, FORTH, ASSEMBLY LANGUAGE, Other, None) This question was presented only to twelfth graders.
- Indicate which of the following video games you have at home. (Atari, Odyssey, Intellivision, Colecovision, Other, None)
- Indicate which of the following types of microcomputers you have used at school. (Atari 400 or 800, TRS-80, Apple, PET-Commodore, IBM, Texas Instruments, Osborne, Other, None)
- Indicate the types of in-school microcomputer learning experience you have had. (Write programs, Generally learn about computers, Drill and practice, Simulations (math or science demonstrations), Tutorial, Instructional games, I have had little experience with computers)
- Indicate where you have learned about computers. (At home, At friends' homes, Special summer programs, Museum of science hall, At school during the day, At school during the evening, Computer stores or salesmen, Playing with video games, I know little about computers)

Students were asked to report demographic information, including sex, and level of parent education. The five possible categories of parent education were:

- Not a high school graduate
- High school graduate
- Some college
- Four-year college graduate
- Advanced degree

That category corresponding to the highest educational level reached by a parent was to be selected.

The test was designed in a matrix format so that each student saw only a small part of the entire pool of questions. Eighty-six unique forms of the test were created, each containing five cognitive test questions, one attitude question and two background questions. The attitude and background questions were assigned to the 86 test forms so that each would appear approximately an equal number of times. A different set of cognitive test questions, selected to cover both computer literacy and computer science objectives, appeared on each form. These were arranged subjectively, in an order from easy to difficult, on each test. The test forms were spiraled for distribution so that each one would be given about the same number of times within each school.

Sixth grade survey. The questions selected for use with sixth grade students were a subset of those developed for twelfth graders. The selected questions were included on the California Assessment Program test, Survey of Basic Skills: Grade 6, which is administered annually to

all public school sixth grade students in California. There are 40 different forms of this test, and each student takes just one form. In addition to the reading, written expression and mathematics questions included on each form, there was space for one additional computer test question. This meant that 40 different computer test questions could be given to sixth grade students.

Twenty-four cognitive test questions were selected. These questions all corresponded to DoDDS objectives, shown in Appendix A, appropriate for elementary grades and all related to computer literacy. The types and number of questions were:

- Objective 1.2.1 Use an appropriate vocabulary (3 questions)
- Objective 1.2.2 Distinguish interactive and batch processing (3)
- Objective 1.2.3 Identify major computer system components (4)
- Objective 1.2.4 Recognize appropriate tasks for a computer (1)
- Objective 1.2.5 Describe major historical developments (2)
- Objective 1.3.4 Develop procedures to perform useful tasks (2)
- Objective 1.3.5 Write simple programs (4)
- Objective 1.4.1 Know specific uses of computers (2)
- Objective 1.4.2 Know computer occupations and careers (3).

In addition to the four regular response options originally included in the questions, sixth graders were permitted an "I don't know the answer" response.

Instead of information on parent education, which was collected from twelfth graders, the sixth grade teachers provided information on parent occupation of students. The possible categories of parent occupation were:

- Professional
- Semi-professional
- Skilled
- Unskilled

The instruction to the teacher was to mark the category which corresponded most closely to the occupation of the family's primary breadwinner.

Sample

Twelfth grade sample. Schools included in this study were sampled randomly. Using statewide test data[3] collected the previous year, high schools were ranked and classified into five equal categories on the basis of number tested (a proxy for school size). Within each size category schools were ranked and classified into five equal groups on the basis of an average index of parent education (a proxy for social class). This resulted in a five by five cross-classification of schools with equal numbers in each of the twenty-five cells. Schools were selected randomly with a probability of p = .125 from each cell. From the original population of 784 schools 98 were selected, containing an estimated 23,395 students. The sample did not differ significantly from the population in terms of achievement or parent education. The sample average number tested per school, N = 239, was smaller than the population average of N = 281, indicating a slight oversampling of small schools. Eighty-seven schools participated in the study in December, 1982, yielding a school response rate of 89 percent. Several schools

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[3] These data were obtained from data tapes produced by the California Assessment Program. All twelfth graders attending California public schools are required to be tested.

declined to participate on the basis that their students were not prepared for such an assessment. Survey questionnaires were received from 17,861 students, yielding an estimated student response rate of 88 percent from participating schools.

Given the matrix format of the test, each of the 430 cognitive test questions was taken by about 200 students. Each of the thirteen attitude questions appeared on six different test forms and was responded to by about 1,200 students. Background questions were placed on the test forms in pairs and about 4,800 students responded to each one.

Sixth grade sample. The Survey of Basic Skills: Grade Six was administered to 293,717 students between April 25 and May 13 of 1983 under standardized conditions. Test forms were assigned to students by an effectively random procedure, with approximately equal numbers of each test form given in each school. As a result each computer test question was given to an average of 7,343 students. Rates of non-response ranged from four to six percent.

Analyses

Analyses were grouped under three headings: performance, attitudes, and experience. Analyses of performance refer to cognitive test questions, analyses of attitudes refer to the rating scale questions, and analyses of experience refer to the background questions.

Performance

Responses to individual cognitive test questions were classified according to DoDDS student objective and aggregated. Average twelfth grade percent correct scores for boys and girls, broken down by the

different categories of parent education are contained in Figures 1 and 2. A similar analysis of sixth grade percent correct scores is shown in Figure 3. Sixth and twelfth grade performance on those questions which were presented to students at both grade levels is summarized in Table 1. Total percent correct scores are shown, along with a breakdown by sex.

Attitudes

Student attitudes toward computer technology are summarized in Table 2. Responses to the statements were coded (strongly disagree=1; disagree=2; undecided=3; agree=4; and strongly agree=5) and average values were computed for the total sample, as well as for boys and girls separately. Average values greater than three indicate a tendency for agreement with the statement, and values less than three indicate disagreement.

Experience

Responses to the background questions, which provided information on student experiences, are summarized in tables 3, 4 and 5. The percent of students responding to each option is shown along with a breakdown by sex. Twelfth grade percent correct on computer science and computer literacy test questions could be calculated for the subgroup of students selecting each option and this is displayed, as well. Percents may not sum to 100 because of the possibility of multiple responses to these questions.

Results

Performance

Average twelfth grade performance is displayed graphically in Figures 1 and 2. These figures reflect the responses of the 17,861 twelfth graders sampled. Average test scores ranged from eighteen percent correct on questions about translation of software among computer languages to a high of 68 percent correct on questions about appropriate tasks for computers. Boys scored consistently higher than girls for all categories of parent education in both computer literacy and computer science. These results may reflect either a tendency for boys to take more advantage of opportunities, or a tendency for parents or teachers to encourage boys more than girls, or come combination of both. Higher levels of parent education were associated with higher test scores. The difference in scores between boys and girls was slightly larger for students from more educated backgrounds than for students from less educated backgrounds. This hints that sex-related differences in achievement are not diminished by increases in parent education and the social advantages which very likely accompany these increases.

Insert Figures 1 and 2 about here.

Average sixth grade computer literacy test scores for the 293,717 boys and girls surveyed, broken down by categories of parent occupation, are shown in Figure 3. Scores were low, ranging from about 16 percent correct to about 33 percent correct. Boys scored consistently higher than girls and students from less skilled parent occupation backgrounds

scored lower than those from more skilled or professional backgrounds. The difference between boys and girls was slightly larger for students from professional backgrounds.

Insert Figure 3 about here.

Twelfth and sixth grade summary performance on a common set of questions is displayed in Table 1. The average percent correct scores in this table are derived from the subset of questions given both to sixth and twelfth grade students. Each objective in this table represents from one to four questions. Twelfth grade total scores are based on 200 to 800 responses, and sixth grade total scores are based on 7,343 to 29,372 responses, depending on the number of questions represented. Although even very small differences are statistically significant, judgements about educational significance are not so clear cut.

Insert Table 1 about here.

With a few exceptions boys scored higher than girls, confirming the results in the figures. Sixth grade boys averaged about 4.0 percent correct points higher than girls, and twelfth grade boys were about 3.5 percent correct points higher. Exceptions to this trend in the twelfth grade were questions on vocabulary where both boys and girls scored a relatively high 82 percent correct and questions on interactive versus batch processing, where girls scored one point higher than boys. Types

of questions for which twelfth grade boys had the greatest advantage over girls were on system components, history and careers. Sixth grade girls scored at the same level as boys in one subject only that is, systematic procedures. Questions on systematic procedures tended to address problem solving skills of a simple nature. Sixth grade boys scored much higher than girls on questions having to do with vocabulary, system components, history, and simple programs.

Areas of strength and weakness tended to be the same in both grades. There were relatively high scores on vocabulary questions. Much lower scores were obtained on questions about simple computer programs. Sixth graders had their lowest scores on questions about interactive and batch processing.

The ability to write and use computer programs is an important outcome of a course on programming. Twelfth grade students were asked to indicate the computer languages they had used to perform these tasks. Forty-three percent of twelfth graders indicated they had never written and used a computer program. The programming languages and percents of students indicating use were: BASIC, 37 percent; PASCAL, three percent; LOGO, three percent; PILOT, two percent; FORTRAN, four percent; COBOL, four percent; FORTH, one percent; ASSEMBLY, five percent; and other languages, five percent. Of the students responding to this question the highest average test scores were attained by the those who had used PASCAL. Of the students who indicated that they used BASIC 54 percent were boys.

Attitudes

Student attitudes toward computer technology are summarized in Table 2. Responses to the statements were coded from 1 to 5, with disagreement receiving lower values and agreement receiving higher values. Average values over three indicate agreement and values less than three indicate disagreement. Each sixth grade total is based on about 7,343 responses and each twelfth grade total is based on about 1,200 responses.

Insert Table 2 about here.

Concerns about privacy and being treated as a number are often associated with computer technology. These are two ways in which computers are sometimes perceived to be dehumanizing. Twelfth grade students, boys and girls alike, tended to disagree slightly with the statements that "Computers treat everyone as a number," and "The more computers are used the less privacy there is." Sixth grade students, by contrast were slightly more likely to agree with the notion that computer treat people like numbers.

Student responses to statements about the role of computers in the workplace were positive and were more pronounced than their responses to statements about privacy and dehumanization. Twelfth grade students tended to agree that "Computers create as many jobs as they eliminate." There was relatively strong twelfth grade agreement with the statements that "A knowledge of computers will help a person to get a better job," and that "Someday most things will be run by computers." The pattern of

sixth grade response was similar. Sixth grade boys tended to believe more strongly than the girls that computers computers will help in obtaining jobs and that computers will be running most things in the future.

There was relatively strong twelfth grade disagreement with the statement that "Computers slow down and complicate business operations." Boys were more in disagreement than were girls. Sixth grade students responded in a similar fashion, although not with quite the same degree of disagreement. Sixth grade boys tended to disagree more strongly than did the girls.

Attitudes, to a certain extent, are shaped by experiences and expectations. It is possible that differences in the experiences and expectations of boys and girls are responsible for the somewhat more positive attitudes of boys towards the role of computers in the workplace. Traditionally, in business, women have been exposed to computers through word processing and automated accounting. To the extent that these types of jobs are perceived as uninteresting by women, this could translate into less positive attitudes.

Many people have associated computers with mathematics. Two aspects of this tendency are that a person must be a mathematician to work with a computer (a myth), and that computers can help to make mathematics more interesting. Both sixth and twelfth grade students tended to disagree with the statement that "Two work with a computer a person must be a mathematician." Despite the tendency to reject this myth it was true that more than one-fourth of the students in both grades either agreed or strongly agreed with the statement. Students in both grades

agreed relatively strongly with the statement that "Computers can help make mathematics more interesting." Boys in both grades were in stronger agreement than girls.

Experience

Understanding the circumstances of learning can help to interpret test scores. Student responses to the question where they learned about computers are summarized in Table 3. For twelfth graders it was possible to provide average computer literacy and computer science percent correct scores for the group of students selecting each option. The design of the sixth grade study did not permit the calculation of similar scores. The 'Friends' option was not available to sixth grade students.

Insert Table 3 about here.

Nearly one-half of twelfth graders reported knowing little about computers. Thirty-nine percent of twelfth grade boys and 51 percent of girls selected this option. Approximately one-third of twelfth graders indicated learning about computers at school and one-fifth said they learned about computers from video games. Six percent more boys at the twelfth grade than girls reported learning about computers at home. Approximately equal percentages of twelfth grade boys and girls said they learned about computers in school. Relatively higher test scores were associated with learning at school, compared to learning from video games. The test scores of students who admitted knowing little about computers were only a few points lower than those who claimed to learn from video games.

Nearly one-half of sixth graders reported knowing little about computers, including 13 percent of the boys and 22 percent of the girls. Relatively large percentages of sixth graders reported learning about computers at school during the day (27 percent) and at home (23 percent). Although a larger proportion of sixth grade girls reported learning about computers in school, boys were more likely to report learning at home. This could indicate a tendency for parents to encourage boys to learn about computers more than girls.

Forty-two percent of sixth graders indicated learning about computers from video games. Many of these students may not have distinguished clearly between computers and electronic games. To the extent that this was so, it would indicate a serious lack of understanding about computers. Less than one-fifth of sixth graders indicated knowing little about computers, and over one-fourth indicated learning at school.

The types of student experiences with microcomputers in school are summarized in Table 4. Approximately 4,800 twelfth grade students and 7,343 sixth grade students responded to this question. The highest average grade twelve test scores in this table were obtained by the 16 percent of students who reported that they wrote computer programs. Eighteen percent of twelfth grade boys, compared to 13 percent of girls reported having written programs. Generally, the proportions of boys were greater than or equal to the proportions of girls in every category of actual use. Lower test scores were obtained by those students who reported playing computer games or who reported using the microcomputer for drill and practice. Over one-half of the twelfth grade students

reported having no in-school microcomputer learning experience. This group included seven percent more girls than boys.

Insert Table 4 about here.

Thirty-two percent of sixth graders, including 29 percent of the boys and 35 percent of the girls, reported no in-school microcomputer learning. The most frequently selected sixth grade use of microcomputers was computer games, including about one-third of the students. Just as in the twelfth grade, the proportions of bys were greater than or equal to the proportions of girls in every category of actual use.

Insert Table 5 about here.

Student responses to whether they had access to a microcomputer at school or to a video game at home are summarized in Table 5. Access to a machine, of course, says little about the use made of it. A microcomputer might be available, but no instruction on may take place. Average computer literacy and computer science test scores of twelfth grade students with access to a microcomputer were about 4.0 points higher than the scores of students without such access. Seven percent more twelfth grade boys and eight percent more sixth grade boys than girls reported having in-school access to a microcomputer. At both grades six and twelve about 60 percent of students reported having school access. There were no strong trends in twelfth grade test scores

in response to the question of access at home to a video game. Roughly one-half of the twelfth graders and two-thirds of the sixth graders reported having a video game at home. At both grades boys were more likely to have access than girls.

Discussion

Perhaps the most striking overall result was the superior performance of boys compared to girls. Both sixth grade and twelfth grade boys had generally higher scores than girls. The reason for this appeared to be that boys had more experience with computers and programming than girls. This was true at school and at home. Sex equity has been an issue in public education and it is likely that related concerns will carry over into the area of computer studies. If students with a background in computer technology benefit professionally from their experience, there needs to be an assurance that specific subgroups of the population are not being discouraged from acquiring that experience. This study does not explain why girls appear to have less experience in computer studies than boys, but it supports the hypothesis that there is a difference.

Overall test scores for both sixth and twelfth grade students were low. To a certain extent these low scores can be ascribed to a lack of experience with computers for many students. Results from the analysis of attitude questions indicated a high level of student awareness of computers. This awareness was not backed up with a corresponding understanding of the basic concepts of computer technology. Even more experienced students, those who reported programming experiences and school instruction in computer technology, did not score well. These results underline the importance of giving consideration both to the

instructional objectives of a course on computer technology, and to effective ways of attaining those objectives.

According to the 1982 National Assessment of Educational Progress survey of mathematics achievement about 20 percent of 13 year olds and 22 percent of seventeen year olds reported knowing how to program. In California 15 percent of sixth graders and 16 percent of twelfth graders reported that they had written and run computer programs. Nationwide, about 23 percent of 13 year olds and 49 percent of seventeen year olds reported having access to a computer in school for learning mathematics. In California, 56 percent of of sixth graders and 57 percent of twelfth graders reported having access to a microcomputer at school. Although greater percentages of California students reported access to a microcomputer, smaller percentages reported using them for programming than was true nationwide.

It is unfortunate that social class, historically, has been correlated with achievement of all kinds. This relationship is clearly demonstrated in the area of computer studies, although possible reasons for it were not so clear. The difference in twelfth grade computer literacy scores between the highest and lowest parent education groups was about three times as large as the difference between boys and girls. Similar differences were found for the sixth grade test scores. It was about one and a half times as large for computer science scores.

It is a truism that people tend to act in accordance with their beliefs. Affective goals are as much a part of the educational process as are cognitive goals. In addition to technical knowledge and skills students should develop a positive regard for the beneficial

capabilities of computers. Ideally, the more one knows about computer technology, the more evident these attitudes should be. Related to this is the ability to recognize popular myths about computers and their implied value judgments. Concerns about privacy and being treated as a number, although valid when understood in the context of the actual capabilities and limits of technology, can be exaggerated in isolation from such knowledge.

Substantial proportions of students at both the sixth and the twelfth grades did not feel that computers were dehumanizing and they rejected popular misconceptions about computers. Even with this relatively high level of awareness and positive outlook it was true that large percentages of students at both grades believed that a person must be a mathematician to work with a computer. This mistaken belief, which appears to be widely held by the public, as well, is evidence that many students need more educating about the basic concepts and uses of computer technology.

Students at both grades tended to see computers as beneficial in the workplace, believed that computers would have an ever larger role in running things, and felt that a knowledge of computers would help in getting a better job. An issue raised by the results concerns student expectations about instruction in computer technology and the relationship of such instruction to preparation for jobs. This study does not fully illuminate these expectations, but the results would be consistent with the notion that students are expecting some type of computer education for jobs. Further issues of interest are the extent to which student expectations mirror the expectations of teachers and parents.

Conclusions

An optimistic conclusion of the current study is that nearly one-half of the students surveyed at both grades had in-school experience with computers. Programming experience, particularly at school, was associated with higher twelfth grade test scores. A majority of students at both grades exhibited awareness of routine characteristics and uses of computers. Test scores for programming objectives were low, however, and mastery of general knowledge was not much better. Comparison of California data with that from the National Assessment of Educational Progress suggested that California students are receiving less programming experience than are students nationwide.

Given enrollment trends in mathematics and science that have favored boys for years, it is not suprising to find a similar trend in the area of computer studies. The greater exposure to computers and understanding of them by boys begins as early as the sixth grade, and is found both at school and at home. This could have negative consequences for women in the long run in the area of job competition. To the extent that computers facilitate the handling of information needed by professionals, not only in mathhematics and science, but in business, medicine, law, etc., there will be an increase in their use. Not to have some facility with computer technology, or to possess some useful understanding of computers, may well be a disadvantage in competing for professional level jobs.

Sex equity is not the only issue to be faced by schools in defining a policy for the use of computers. A larger question refers to the role of schools in educating students. Is it proper for public schools to

provide students with entry level skills for use in obtaining jobs? This would imply relatively close cooperation between schools and industry? Or should schould schools only provide students with an understanding or awareness of computers that would prepare them for further training in higher education? Answers to these questions will affect the expenditure of public school resources in three areas: acquisition of equipment; acquisition of software; and staff development. State governments, professional associations, and governing bodies of schools need to be concerned with the making of these decisions, and there needs to be more public discussion of the benefits and costs associated with different choices. Presumably, research into the availability and use made of computer hardware and software, and related staff development, is needed to help clarify these issues.

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Appendix A

STUDENT OBJECTIVES

1. Demonstrate understanding of the capabilities, applications, and implications of computer technology. (239)
    1. Interact with a computer and/or other electronic devices. (42)
        1. Demonstrate ability to operate a variety of devices which are based on electronic logic. (8)
        2. Demonstrate ability to use a computer in the interactive mode. (13)
        3. Independently select a program from the computer resource library. (9)
        4. Recognize user errors associated with computer utilization. (12)
    2. Explain the functions and uses of a computer system. (91)
        1. Use an appropriate vocabulary for communicating about computers. (25)
        2. Distinguish between interactive mode and batch mode computer processing. (9)
        3. Identify a computer system's major components such as input, memory, processing, and output. (20)
        4. Recognize tasks for which computer utilization is appropriate. (14)

5. Describe the major historical developments in computing. (23)

3. Utilize systematic processes in problem solving. (58)
   1. Choose a logical sequence of steps needed to perform a task. (10)
   2. Diagram the steps in solving a program. (7)
   3. Select the appropriate tool and procedure to solve a problem. (11)
   4. Develop systematic procedures to perform useful tasks in areas such as social studies, business, science and mathematics. (12)
   5. Write simple programs to solve problems using a high level language such as PILOT, LOGO and BASIC. (18)
4. Appraise the impact of computer technology upon human life. (48)
   1. Identify specific uses of computers in fields such as medicine, law enforcement, industry, business, transportation, government, banking and space exploration. (12)
   2. Compare computer-related educations and careers. (13)
   3. Identify social and other non-technical factors which might restrict computer utilization. (10)
   4. Recognize the consequences of computer utilization. (11)
   5. Differentiate between responsible and irresponsible uses of computer technology. (2)

2. Demonstrate understandings of computer systems including software development, the design and operation of hardware, and the use of computer systems in solving problems. (191)
    1. Write structured and documented computer software. (95)
        1. Write well organized BASIC programs which include the use of color, sound and graphics statements. (41)
        2. Write programs which demonstrate advanced programming techniques used to solve problems in business, scientific or entertainment applications. (19)
        3. Write programs in an additional high level language such as PASCAL, COBOL or FORTRAN. (25)
        4. Write programs in a low level language such as machine language or assembler. (10)
    2. Demonstrate knowledge of the design and operation of computer hardware. (57)
        1. Demonstrate unassisted operation of at least two different configurations of computers and their peripherals. (16)
        2. Use a special purpose computer or computer interfaced devices to monitor or control events by sensing temperature, light, sound, or other physical phenomena. (10)
        3. Describe the computer's digital electronic circuitry in terms of of binary arithmetic and logical operators. (19)
        4. Perform vendor authorized minor maintenance on the computer system. (12)

3. Use computer systems in problem solving. (39)
    1. Use data processing utilities including word processing and data base management in problem solving. (12)
    2. Translate software from one language to another or to another version of the same language. (11)
    3. Analyze different solutions to the same problem. (16)

Table 1

Twelfth and Sixth Grade Percent Correct Scores

	Percent Correct					
	Twelfth Grade			Sixth Grade		
Objective	Total	Boys	Girls	Total	Boys	Girls
Overall	56	58	54	27	29	25
1.2.1 Vocabulary	82	82	82	46	50	42
1.2.2 Interactive and Batch	36	36	37	9	10	8
1.2.3 System Components	58	61	54	30	33	27
1.2.5 History	54	57	50	19	22	15
1.3.4 Systematic Procedures	72	73	72	35	35	35
1.3.5 Simple Programs	35	36	33	22	24	20
1.4.1 Specific Uses	87	89	84	37	38	36
1.4.2 Careers	48	52	45	24	25	22

Table 2

Student Attitudes Toward Computer Technology

Statement	Attitude Index					
	Twelfth Grade			Sixth Grade		
	Total	Boys	Girls	Total	Boys	Girls
Computers treat everyone as a number	2.89	2.87	2.93	3.12	3.13	3.10
The more computers are used the less privacy there is	2.96	2.97	2.94	2.98	2.93	2.98
Computers create as many jobs as they eliminate	3.13	3.07	3.21	3.29	3.30	3.28
Computers slow down and complicate business operations	1.93	1.83	2.08	2.63	2.57	2.72
A knowledge of computers will help to get a better job	3.97	3.97	3.91	3.74	3.86	3.67
Someday most things will be run by computers	4.05	4.03	4.04	3.74	3.83	3.67
Computers can help make mathematics more interesting	3.88	3.92	3.77	3.88	3.96	3.81
To work with a computer a person must be a mathematician	2.72	2.68	2.74	2.80	2.84	2.79

Table 3

Where learned about computers

	Test Scores		Subgroup Percents					
	Computer	Computer	Twelfth Grade			Sixth Grade		
Question	Literacy	Science	Total	Boys	Girls	Total	Boys	Girls
Home	46	34	14	17	11	23	25	20
Friends	45	33	10	13	7	.	.	.
Summer	46	36	3	4	4	4	4	3
Museums	45	36	2	2	2	4	4	3
School (day)	47	35	28	29	28	27	26	29
School (evening)	47	39	2	3	2	3	3	2
Stores	48	31	6	9	4	10	13	7
Video games	41	30	21	25	17	42	46	39
Know little	39	27	45	39	51	47	13	22

Table 4

Types of in-school microcomputer learning

	Test Scores		Subgroup Percents					
			Twelfth Grade			Sixth Grade		
Question	Computer Literacy	Computer Science	Total	Boys	Girls	Total	Boys	Girls
Write programs	57	47	16	18	13	15	16	13
General information	57	45	17	17	17	15	16	14
Drill and practice	54	43	11	12	11	13	13	13
Demonstrations	56	43	8	9	8	15	16	14
Tutorial	55	47	5	5	5	.	.	.
Computer games	52	39	12	14	11	33	35	31
No experience	49	34	53	50	57	32	29	35

Table 5

Student Access to Computer Technology

	Test Scores		Subgroup Percents					
			Twelfth Grade			Sixth Grade		
Question	Computer Literacy	Computer Science	Total	Boys	Girls	Total	Boys	Girls
Access to a microcomputer at school								
Yes	48	30	57	61	54	56	60	52
No	44	26	43	39	46	44	40	48
Access to a videogame at home								
Yes	49	31	47	50	44	65	73	57
No	48	32	53	50	56	35	27	43

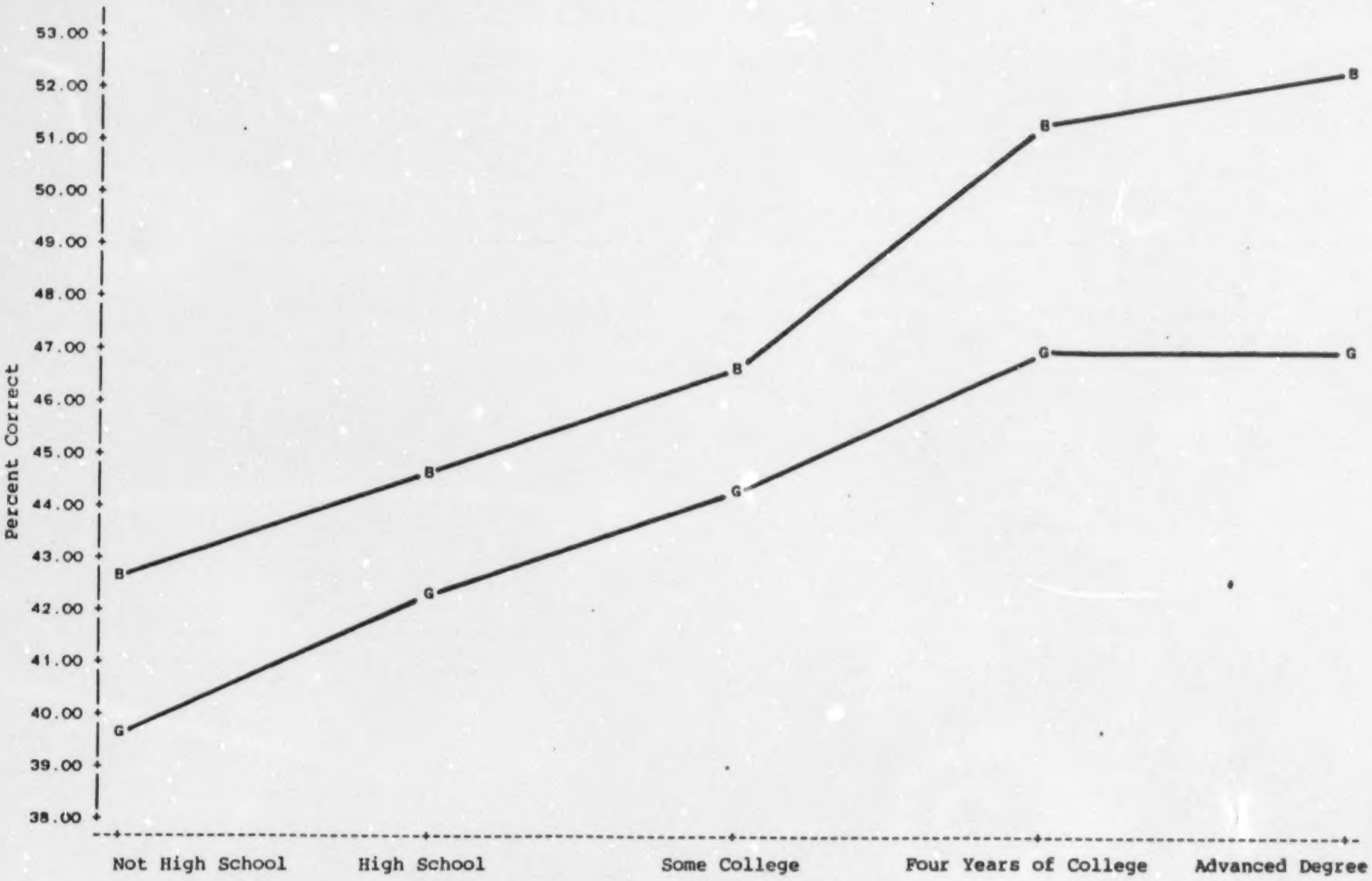

Figure 1. Twelfth grade computer literacy percent correct for boys(B) and girls(G) by parent educational level

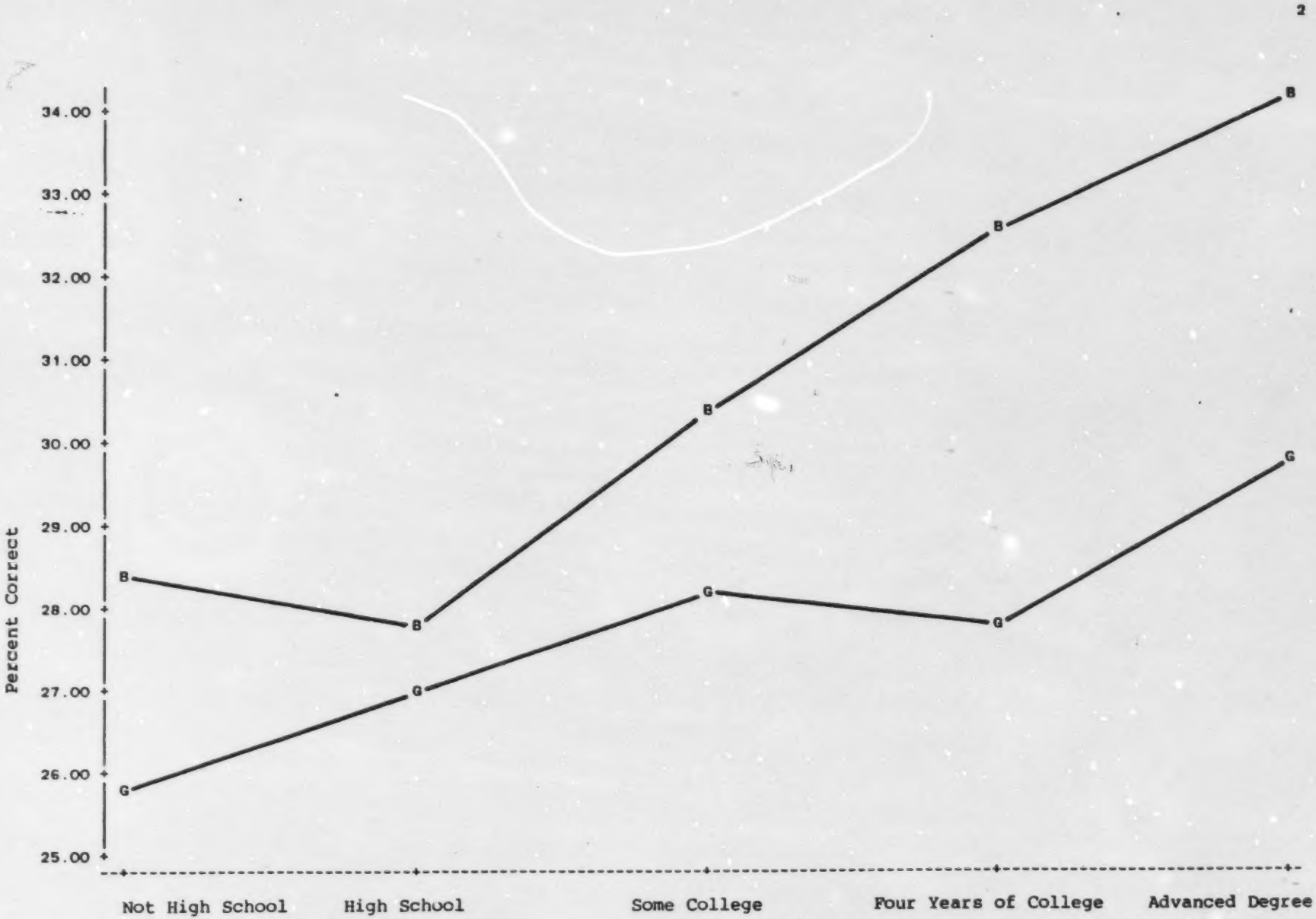

Figure 2. Twelfth grade computer science percent correct for boys(B) and girls(G) by parent educational level.

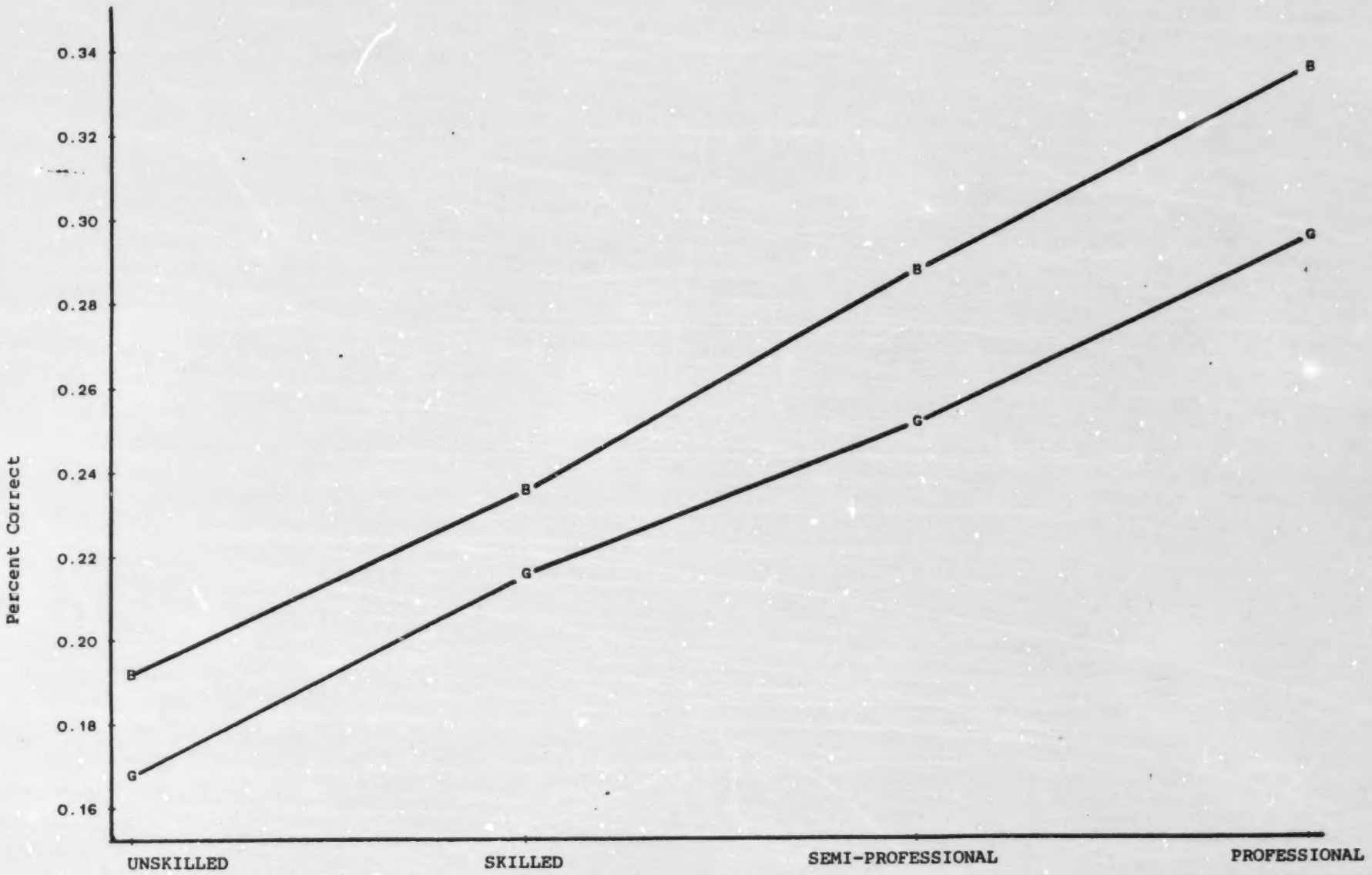

Figure 3. Sixth grade computer literacy percent correct for boys(B) and girls(G) by parent occupational level.